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REPORT OF THE METEOROLOGICAL STATION AT BERKELEY, CAL., FOR THE YEAR ENDING JUNE 30, 1913.[1]

By WILLIAM GARDNER REED, Ph. D.

[Dated University of California, Berkeley, Cal., Apr. 7, 1914.]

The University of California has carried on meteorological work at Berkeley (lat. 37° 52′ N., long. 122° 16′ W. Gr.; H, 98 meters; h_t, 1.5 meters; h_r, 4.6 meters) since October 16, 1886, in cooperation with the United States Signal Service and its successor, the Weather Bureau. This work was a part of the activities of the Students' Observatory until July 1, 1912, when it passed to the Department of Geography. This report is the first of a series of annual reports to be issued by the university.

During the fiscal year ending June 30, 1913, the following observations were made at 8 a. m. and 8 p. m. Pacific time:

1. Temperature of the air (dry-bulb thermometer).
2. Temperature of evaporation (wet-bulb thermometer).
3. Maximum temperature in the preceding 12 hours.
4. Minimum temperature in the preceding 12 hours.
5. Pressure of the air.
6. Amount of cloud, and weather.
7. Wind direction and estimated velocity.
8. Precipitation in the preceding 12 hours.

In addition to the observations at the regular hours, a record has been kept of the general character and prevailing wind direction of each day, the times of beginning and ending of precipitation, of the occurrence and character of fog, and of the occurrence of frost; an attempt has been made to record occasional meteorological phenomena of interest. The recording instruments have furnished continuous records of air temperature, air pressure, and relative humidity; these automatic records are complete from the times of the installation of the instruments and are correct except for such errors as are inherent in the instruments and which are not large.

The results of the observations have been recorded as made upon blank forms of the United States Weather Bureau. In addition to the figures obtained by observation, the following have been computed for each observation: Air pressure, corrected for temperature and local gravity; air pressure at sea level; dew point; relative humidity; and pressure of aqueous vapor. The range of temperature and the mean temperature for each day, the change from the mean of the preceding day, and the total precipitation for each day have been computed.

The instruments were exposed on the campus of the University at Berkeley, 19 kilometers (12 miles) east-northeast from the Golden Gate and the Pacific Ocean. The slope from the campus to San Francisco Bay is gentle, about 90 meters, 300 feet, in 3 kilometers, 2 miles. To the east the Berkeley Hills rise abruptly to elevations of over 300 meters, 1,000 feet, above sea level. The thermometer shelter and the rain gage are located at the Students' Observatory, on the west side of a small hill. This location probably provides good air drainage, with the result that temperatures at the location of the thermometers are probably higher than those at the bottom of the valley a few hundred meters away.

A summary of the meteorological conditions at Berkeley for the year will be found in Table 1 [omitted].

It was deemed advisable to use the C. G. S. system of absolute units as this report begins a new series and no previous reports have determined the style so that rational units may be used without complication. For this reason the question was decided wholly on the basis of the proper units.

Owing to a change in the thermometer exposure the temperatures for the year are not strictly comparable with those of preceding years. In general the temperatures under the freer new exposure show higher maxima and lower minima than under the former conditions.

Table 1 [omitted] shows the weather conditions for each month of the year. Days with less than three-tenths of the sky was cloud covered through the day, or on which the sky cloud covered for less than three-tenths of the time, were recorded as clear. Days with more than seven-tenths of the sky covered through the day, or cloudy more than seven-tenths of the time, were recorded as cloudy. All other days were recorded as partly cloudy. The partly cloudy days fall into two classes, those on which the sky was more than three but less than seven-tenths cloudy throughout the day, and those on which the sky was overcast or nearly so for a part of the day and clear for a part of the day; in either case the average amount of cloud for the day was between three-tenths and seven-tenths. The type of day on which the sky was partly cloudy throughout the day is more usual in the winter than in the summer months; it is generally associated with the margin of a cyclone, and may occur at the beginning or toward the end of a passage with the center near the station, or during the passage of a cyclone with the center at some distance from the station. The other type of partly cloudy day is probably the more common at Berkeley. In summer this type occurs with fog or "high fog" in the morning or evening hours, or both, while the greater part of the daytime hours are clear. In winter there is a similar condition when "tule fogs" have drifted southward from the marshes of Suisun Bay and the Sacramento River. The two types of partly cloudy day are the cyclonic, which is the first-mentioned, and the noncyclonic of the summer and the anticyclonic of the winter, which together constitute the second type mentioned.

The monthly extreme temperatures since the opening of the station are given in Table 2.

[1] *Abstract of* University of California Publications in Geography, v. 1 (No. 6), pp. 247–306, issued Apr. 7, 1914.

TABLE 2.—*Extreme temperatures at University of California, July 1, 1887, to June 30, 1913.*

Month.	Maximum.			Minimum.		
	° *A.*	° *F.*	*Date.*	° *A.*	° *F.*	*Date.*
July	309.3	97.3	7,1905	278.7	42.3	29,1899
August	307.1	93.4	22,1891	281.0	46.4	31,1905
September	311.2	100.8	18,1912	280.7	45.9	28,1905
October	307.4	94.0	8,1899	277.1	39.3	18,1905
November	300.8	82.0	16,1895	273.6	33.0	28,1905
December	293.9	69.6	24,1901	272.4	31.0	24,1905
January	298.0	77.0	26,1899	269.1	24.9	14,1888
February	299.4	79.5	18,1899	271.4	29.2	12,1905
March	298.8	78.5	29,1911	274.1	33.9	30,1905
April	303.3	86.6	24,1913	275.2	36.0	19,1896
May	306.6	92.5	26,1896	277.4	39.9	1,1899
June	311.4	101.1	6,1903	278.8	42.4	2,1903
Year	311.4	101.1	Je.6,1903	269.1	24.9	Jn.14,1888

NOTE.—Minimum temperatures for January and February, 1908, are not available.

PRECIPITATION.

The total precipitation of all kinds for the year 1912–13 was 397.2 millimeters, 15.63 inches. The monthly and seasonal rainfall of Berkeley from 1887 to 1912 has been compiled and was published in the Monthly Weather Review for April, 1913.[2] In addition to these two, the monthly rainfall and the total from July 1 to the end of each month, with the departures from the average for the same period, have been compiled for Table 3.

TABLE 3.—*Monthly and accumulated precipitation at University of California for 1912–13 with averages for 26 years and departures from the averages.*

Month.	Monthly.		Accumulated to end of month.		Average accumulated.		Departure 1912-13.	
1912.	*Mm.*	*In.*	*Mm.*	*In.*	*Mm.*	*In.*	*Mm.*	*In.*
July	0.0	0.0	0.0	0.0	0.5	0.02	− 0.5	− 0.02
August	0.0	0.0	0.0	0.0	1.5	0.06	− 1.5	− 0.06
September	37.1	1.46	37.1	1.46	16.8	0.66	+ 20.3	+ 0.80
October	17.8	0.70	54.9	2.16	53.6	2.11	+ 1.3	+ 0.05
November	98.8	3.89	153.7	6.05	119.3	4.70	+ 34.4	+ 1.35
December	41.2	1.62	194.9	7.67	223.4	8.80	− 28.5	− 1.13
1913.								
January	96.0	3.78	290.9	11.45	368.9	14.35	− 78.0	− 3.08
February	16.3	0.64	307.2	12.09	470.8	18.54	−163.6	− 6.45
March	50.3	1.98	357.5	14.07	593.6	23.37	−236.1	− 9.30
April	14.5	0.57	372.0	14.64	630.5	24.82	−258.5	−10.18
May	25.2	0.99	397.2	15.63	659.5	25.96	−262.3	−10.33
June	T.	T.	397.2	15.63	664.9	26.17	−267.7	−10.54
1912–13.								
Season	397.2	15.63	397.2	15.63	664.9	26.17	−267.7	−10.54

The rainfall year was one of marked shortage in precipitation, as may be seen from an examination of Table 3. By itself the past year will stand out as one of the very dryest years of the record, but the condition of drought is especially noteworthy because the preceding season, that of 1911–12, was one of very little rainfall. Never since the establishment of the station have two such dry seasons occurred in succession, and consequently there is a marked shortage at the end of the season of 1912–13.

The number of days with precipitation amounting to 0.25 millimeter, 0.01 inch, or more, were 58 during the year, and the number of days with 1.0 millimeter, 0.04 inch, or more, were 46. The average for the 26 years is 65 days, with 0.25 millimeter, 0.01 inch, and 53 days with 1.0 millimeter, 0.04 inch. These days are those on which the amounts were collected by the rain gage; there may have been a few other days on which the amounts fell, but the catch of the gage is probably not far from the true amount of rainfall. On certain days, which number about five for the year, the precipitation was collected from fog, but the total amount from this source is small, probably not over 1.25 millimeters, 0.05 inch, for the whole year. All the other days on which 0.25 millimeter, 0.01 inch, was collected are to be regarded as true rainy days, especially those on which more than 1.0 millimeter, 0.04 inch, was recorded, as in no case did the precipitation from fog much exceed the minimum measurable amount.

[2] W. G. Reed, The rainfall of Berkeley, Cal. Mo. Weath. Rev., Washington, 1913, 41, p. 625–627. Published in more extended form in Univ. Calif. Publ. Geog., 1, p. 63–79 (No. 2, 1913).

Cyclonic rainfalls.

Although practically all the rain at Berkeley is the result of cyclonic activity, it has not been easy in all cases to assign the precipitation of a given day to a particular cyclone. In fact, the cyclonic relations in the Pacific coast region are somewhat complicated, rather important pressure fluctuations taking place while a single cyclone seems to be the dominant control of the weather, instead of the simpler fall in pressure as the cyclone approaches and the rise in pressure after the center has passed. In view of the importance of the cyclone as the control of precipitation at Berkeley, Table 4 has been constructed. This table includes all the precipitation for times at which depressions or unsettled conditions of pressure could be determined from the barograph trace. By a somewhat liberal interpretation it has been possible to include under the 18 cyclones given in Table 4 precipitation amounting to 394.4 millimeters, 15.52 inches, or all but 2.8 millimeters, 0.11 inches, of the total for the year. Of this amount 1.0 millimeter, 0.04 inch, was from fog, which leaves only 1.8 millimeters, 0.07 inch, of the rain not accounted for by cyclones. This amount was all recorded on April 12, and is shown by the weather maps to be almost surely of cyclonic origin; it has been omitted from Table 4 because the barograph trace does not show clear cyclonic characteristics.

TABLE 4.—*Cyclonic rainfall at Berkeley, Cal., 1912–13.*

No.	Date.	Precipitation.		Barograph trace.	Weather map notes.
		Mm.	*In.*		
1	Sept. 2	2.3	0.09	Faint depression	Low over Vancouver 2d; breaking up 3d.
2	Sept. 5–6	34.8	1.37	.....do	Low off Washington coast, moving east.
3	Oct. 22–29	17.8	0.70	Unsettled	Strong low off Washington 21st–23d, moving east; low crossing Washington 24th–26th; lows in southern plateau States and Washington 26th–29th.
4	Nov. 3–10	90.1	3.55	Unsettled with two moderate depressions.	Lows crossing Washington and Oregon; subordinate lows in Nevada.
5	Nov. 12–15	1.3	0.05	Moderate depression	
6	Nov. 18–20	7.4	0.29	.....do	Low crossing southern British Columbia.
7	Dec. 13–17	38.4	1.51	Marked depression 14th and 15th.	Large low crossing southern British Columbia.
8	Dec. 30–31	2.8	0.11	Weak depression	Large low off coast of northwestern United States.
9	Jan. 7–11	20.1	0.79	Marked depression	Low in Northwestern States, later in the plateau States.
10	Jan. 11–19	74.7	2.94	Marked depression 11th–17th, unsettled 17th–19th.	Large low central in Northwestern States, moving east.
11	Jan. 20–23	1.0	0.04	Marked depression	Follower of the preceding, moving east.
12	Feb. 5–10	2.8	0.11	.....do	Marked low crossing southern California.
13	Feb. 20–28	12.7	0.50	Moderate depression 20th–22d, marked depression 23d–28th.	Large low area central in British Columbia and Arizona, later in California, Northwest and plateau States, Oregon, California, and moving east.
14	Mar. 15–25	50.3	1.98	Depressions: Marked 15th–18th, unsettled 18th–21st, weak 21st–26th.	Low in British Columbia and Washington with trough to Arizona; moving east.
15	Apr. 2–8	12.7	0.50	Weak depression	Low in British Columbia.
16	May 8–9	5.6	0.22	Very faint depression	Weak low in Northwestern States.
17	May 15–19	8.9	0.35	Faint depression	Low over Nevada, moving east.
18	May 27–29	10.7	0.42	Very weak depression.	Low over Nevada.

WIND.

Observations of wind direction have been made at the morning and evening hours; the results are tabulated under the heading "Winds at 8 h. and 20 h. (number of observations)" in Table 1 [omitted.] This part of the table shows the winds actually observed on the campus in the morning and evening as far as they can be determined. All wind directions at Berkeley must be estimated, as the equipment of the station does not include a vane and no accurate compass directions have been laid down on the campus. In general the observations have been made from the drift of smoke and from the flag on the campus, so that the directions must be regarded as approximations and not the actual conditions of air movement. These give fairly accurate directions for the morning hour, but the directions are more uncertain at night.

The topography of Berkeley and its vicinity probably has a strong local influence on the wind direction, which may amount to actual control in some cases. The canyon of Strawberry Creek through the western line of hills bordering the campus must have some effect on the wind direction. Although no detailed study has been made of the local air drainage, it is certain from casual observations that there is frequently in the evening a draft down from Strawberry Canyon across the campus. There are, however, no observations which show whether there is an up-canyon draft in the daytime. It would not be surprising to find that the trend of the faces of the hills and the existence of Strawberry Canyon exert a marked influence on the direction of the wind at the university campus.

CONCLUSION.

The mean annual temperature at Berkeley during the year 1912–13 was about 287°A., 57°F., with a mean annual range of 10°A., 19°F., and an extreme range of over 40°A., 70°F. The mean maximum temperature was 292°A., 66°F., and the mean minimum 281°A., 47°F. The mean monthly range was 21°A., 38°F., the mean daily range 10°A., 19°F., and the mean change from day to day 1.4°A., 2.6°F. September was the warmest month of the year and January was the coldest; January was probably abnormally cold, but no other month had a very unusual temperature. Frost was probably more frequent in December and January than the average for the whole period of the record for these months.

The pressure of the water vapor of the atmosphere was in general less than 13 millibars (10.0 millimeters or 0.4 inch of mercury), the relative humidity averaged slightly more than 80 per cent morning and night, and the mean dew point was about 275° A., 36° F., in the winter and about 286° A., 56° F., in summer. The vapor pressure and the dew point showed a strong tendency to vary with the air temperature. Not quite half the days of the year were generally clear, but only a quarter of the days were generally cloudy and many of the partly cloudy days had several hours of bright sunshine. Fog was observed on 40 days and "high fog" on about as many more, which is probably about the average for Berkeley.

The total precipitation for the year was 397.2 millimeters, 15.63 inches, which is 267.7 millimeters, 10.54 inches, less than the average. September and November had more than the average rainfall, but all the other months had less than the average. Snow fell on one day in January. There were 58 rainy days during the year, which is slightly less than the average; in five months of the year there were more than the average number of rainy days, and in five there were less than the average number, July and August being omitted from consideration, as they are generally dry. The heaviest fall of rain in any one day of the year was 60.7 millimeters, 2.39 inches, on November 6; this was the only day on which as much as 25 millimeters, 1 inch, fell. The precipitation of the year was mainly the result of 18 cyclones, the centers of most of which passed far north of Berkeley, but the cyclones were near enough to control the weather at the station.

The wind was largely from southerly and westerly directions in the average for the year, both in the prevailing directions by days and at the observation hours. The westerly element was more marked in the summer months. Calm days were rare, although no wind movement was observed at about one-fifth of the observation hours.

ELECTRIC PARAGRÊLES.[1]

By A. ANGOT, Director, Bureau Central Météorologique de France.

[Translated by R. E. Edwards from Annuaire, Soc. météorol. de France, Mars, 1914.]

It is unnecessary to review the objections that I have heretofore given against the use of cannons or rockets for protection from hail. These processes have always seemed to me to be of doubtful efficiency; but they have their origin at least in a legitimate idea, they seek to attack a thunderstorm cloud directly and to destroy it.

The electric "niagara" apparently has not even this advantage. It is founded on the erroneous idea that hail is an electrical phenomenon.

Without wishing to enter into the details of the matter, it is sufficient to point out the fact that the electrical manifestations, lightning and thunder, are not the cause of storms, but a result of much more extensive meteorological phenomena which are connected with the general circulation of the atmosphere.

The primary phenomenon is an ascending current (generally accompanied by a barometric depression) which causes the formation of a special cloud, designated cumulo-nimbus by meteorologists. In certain cases it has been possible to follow the process of the ascending air current and of the corresponding cumulo-nimbus over very large areas, such as the whole of Europe, Great Britain, and Russia.

The ascending current and the cumulo-nimbus which it produces, undergo in their progress constant modifications; the local manifestations depend on the violence of the phenomena.

Everywhere we may observe the passage of the cumulo-nimbus; over certain regions this passage will be accompanied by more or less heavy showers, phenomena less general than the cloud; in more limited regions, more serious indications will be manifested; lightning and thunder; that is, a thunderstorm and hail. But these last two indications are not necessarily associated. Thunderstorms may occur without hail or hail without thunderstorms. Admitting that a "niagara"—that is, a lightning rod—can act on electrical manifestations, we do not see what influence it could exert on a phenomenon such as hail, in whose production electricity plays no part.

Moreover, hail forms at altitudes such as seem to be not easily accessible with our means of action. In order that a hailstone may form, it is necessary that the surrounding temperature be less than 0° C. Supposing that the temperature at the ground be only 25° C., which is

[1] Extrait de la communication faite à la Société nationale d'agriculture de France, séance du 4 février, 1914.